



РОССИЙСКАЯ АКАДЕМИЯ НАУК
РОССИЙСКИЙ ФОНД
ФУНДАМЕНТАЛЬНЫХ ИССЛЕДОВАНИЙ
ИНСТИТУТ ОКЕАНОЛОГИИ
ИМ. П.П.ШИРШОВА РАН



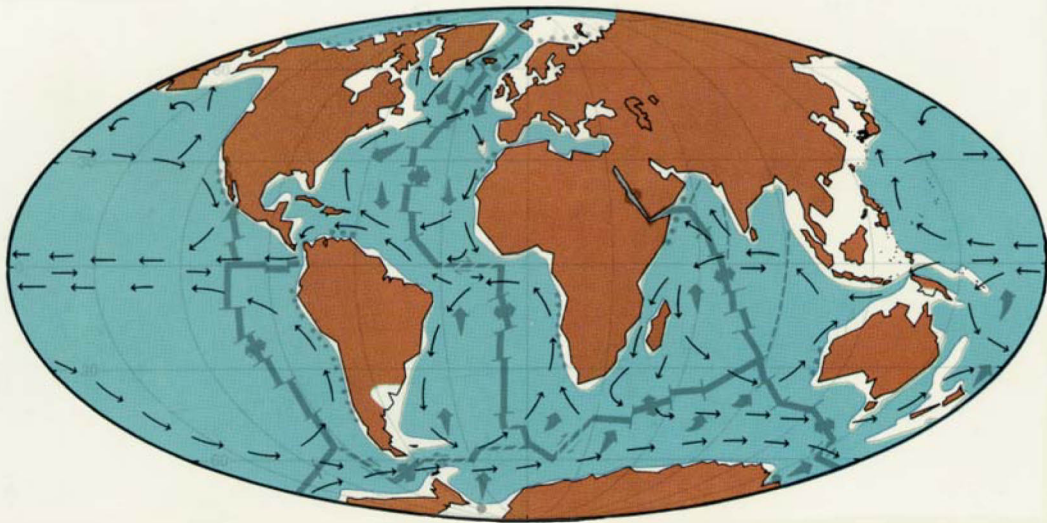
Материалы
XX
Международной
научной
конференции
(Школы)
по морской
геологии

Москва

2013

ГЕОЛОГИЯ МОРЕЙ И ОКЕАНОВ

Том V



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**ГЕОЛОГИЯ
МОРЕЙ И ОКЕАНОВ**

**Материалы XX Международной научной конференции
(Школы) по морской геологии**

Москва, 18–22 ноября 2013 г.

Том V

**GEOLOGY
OF SEAS AND OCEANS**

**Proceedings of XX International Conference on Marine
Geology**

Moscow, November 18–22, 2013

Volume V

Москва / Moscow
ГЕОС / GEOS
2013

ББК 26.221
Г35
УДК 551.35

**Геология морей и океанов: Материалы XX Международной научной конференции (Школы) по морской геологии. Т. V. – М.: ГЕОС, 2013. – 372 с.
ISBN 978-5-89118-640-8**

В настоящем издании представлены доклады морских геологов, геофизиков, геохимиков и других специалистов на XX Международной научной конференции (Школе) по морской геологии, опубликованные в пяти томах.

В томе V рассмотрены проблемы, связанные с геофизикой и геоморфологией дна морей и океанов, тектоникой литосферных плит.

Материалы опубликованы при финансовой поддержке Отделения наук о Земле РАН, Российского Фонда Фундаментальных Исследований (грант 13-05-06021), издательства ГЕОС.

Ответственный редактор
Академик А.П. Лисицын

Редакторы к.г.-м.н. Н.В. Политова, к.г.-м.н. В.П. Шевченко

Geology of seas and oceans: Proceedings of XX International Conference on Marine Geology. Vol. V. – Moscow: GEOS, 2013. – 372 p.

The reports of marine geologists, geophysics, geochemists and other specialists of marine science at XX International Conference on Marine Geology in Moscow are published in five volumes.

Volume V includes reports devoted to the problems of sea floor geophysics and geomorphology, lithosphere plate tectonics.

Chief Editor
Academician A.P. Lisitzin
Editors Dr. N.V. Politova, Dr. V.P. Shevchenko

ISBN 978-5-89118-640-8
ББК 26.221

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Тектоногенные структуры в рельефе Срединно-Атлантического хребта

Zheleznov A.M.¹, Smith D.K.², Palmiotto C.^{3,4}, Parnell-Turner R.E.⁵, Schouten H.², Cann J.R.⁶, Dziak R.P.⁷, Dick H.J.B.², Bai H.⁸

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Tectonically active terrains on the Mid-Atlantic Ridge

В докладе приводятся результаты экспедиций по исследованию Срединно-Атлантического хребта, которые состоялись в 2012 и 2013 гг. на судах Вудс-Холского океанографического института под руководством Деборы Смит (США). Целью данных работ являлось изучение морфологии и геодинамической истории развития сегментов Срединно-Атлантического хребта (САХ), на которых широко представлен тектоногенный рельеф внутренних океанических комплексов (перевод англоязычного термина “oceanic core complex” по Силантьеву С.А.). Собственно внутренним океаническим комплексом (ВОК) является комплекс пород габбро-перидотитовой ассоциации, слагающих эти прифланговые поднятия. На склонах ВОК, хорошо заметных на батиметрических картах, сторона, обращённая к оси хребта, обычно выположена и отличается специфичным гофрированным микрорельефом. При этом именно по этому склону и обнажаются глубинные породы. Изначально предполагалось, что подобные структуры могут возникать только по краям сегментов разного порядка у медленноспрединговых хребтов (то есть преимущественно в зонах сочленения рифтовой долины с трансформными разломами), но последние исследования показывают, что подобные массивы могут занимать до 50% [1] площади дна рифтовой долины на медленноспрединговых хребтах.

Структуры пологих куполов ВОК пока ещё содержат целый ряд научных загадок из областей океанологии, тектоники, геологии глубинных пород, геотермии, геохимии, морской биологии и, конечно, геоморфологии срединно-океанических хребтов. Материалы последних исследований авторов позволяют оценить положение и роль ВОК в общем рельефе САХ за счёт обширного покрытия батиметрической и, отчасти, геофизической съёмкой.

В ходе рейса АТ21-03 (НИС “Atlantis”, WHOI, июнь–июль 2012) основной задачей являлось размещение трёх автономных гидрофонов, которые в составе общей сети из восьми устройств должны собрать за 2012–14 годы детальную информацию о сейсмичности в экваториальной Атлантике. Подобные работы в северной Атлантике позволили [2] оценить тектоническую активность, которая связана с развитием ВОК по разломам типа детачмент.

В рейсе КNR-210-5 (НИС “Knorr”, WHOI, май–июнь 2013) крупномасштабные геофизические и геологические работы проводились на конкретном участке САХ в районе неактивного гидротермального поля Краснов (поле подробно описано в [3]), напротив которого зафиксирована и детально исследована серия ВОК (в границах сектора $16^{\circ}20'–16^{\circ}50'$ с.ш.). Для работ использовался широкий спектр оборудования: глубоководный обитаемый аппарат “Sentry”, подводная фотокамера, магнитометр, гравиметр, многолучевой эхолот, геофизические сенсоры, но для пробоотбора применялись исключительно драги.

По ходу движения к районам основных работ получен уникальный материал многолучевой съёмки дна. Целый ряд материалов подтверждает развитие ВОК на западном и восточном флангах далеко за пределами осевой зоны САХ. Также среди участков дна, которые покрыты батиметрической съёмкой, необходимо отметить внутритрансформное поднятие трансформной зоны Долдрамс ($7^{\circ}20'$ с.ш.), неовулканическую зону на $5^{\circ}30'$ с.ш. и глубоководные каналы на континентальном склоне Бразилии в районе впадения Амазонки в Атлантику.

В настоящее время ещё продолжается обработка экспедиционных данных, но уже можно сделать предварительные выводы. Развитие сектора сектора $16^{\circ}20'–16^{\circ}50'$ с.ш. не было симметричным на западном и восточном флангах, но примерную скорость спрединга за последние 4 млн. лет в этом секторе можно оценить в ~ 24 км/млн. лет. Если восточный склон рифтовой долины представлен базальтовой грядой, то западный разорван на отдельные поднятия ВОК сериями разновозрастных детачментов. Данный участок также можно разделить и на северный и южный сегменты: северный характеризуется значительной глубиной в осевой части, а южный отличается активной неовулканической зоной.

В 2014 г. авторами будут подняты гидрофоны, данные о сейсмичности с которых будут сразу же опубликованы и позволят оценить распространение землетрясений в Атлантическом океане на значительном отрезке от 20° с.ш. до 20° ю.ш.

Авторы благодарны капитанам, коллегам и членам команды, которые работали вместе с нами в обоих рейсах. Данное исследование стало возможным благодаря частичному финансированию NSF и InterRidge.

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Here we present multibeam and geophysical data, collected during AT21-03 (WHOI, 2012) and KNR-210-5 cruises (WHOI, 2013). The goal of this project is to increase our understanding of the morphology and the geodynamic history of the formation of oceanic core complexes (OCC's) on the Mid-Atlantic Ridge (MAR). OCC's are corrugated massifs in which lower-crustal and upper-mantle rocks such as gabbros and serpentinized peridotites are exposed at the seafloor on long-lived faults known as detachment faults.

During expedition AT21-03 on the R/V Atlantis in June–July 2012, our primary goal was to deploy two autonomous hydrophones and service another in the equatorial Atlantic in order to complete an array of eight instruments. Five hydrophones had already been deployed during previous cruises. The array of eight hydrophones is obtaining a two-year, continuous record of seismicity along the MAR between 20°N and 20°S (2012–2014), which will provide a detailed view of the spatial and temporal patterns of seismicity near the spreading ridge and its transforms. Autonomous hydrophones deployed in the North MAR study area (1999–2005) indicated high rates of seismicity were correlated to active detachment faults.

The aim of the cruise KNR-210-5 on the R/V Knorr in May - June 2013 was to understand the processes controlling the formation, evolution, and linking of mid-segment detachment faults and to examine the relationship between magma supply and detachment fault formation along a segment of the MAR axis. The study area was located at 16.5°N on the opposite side from the inactive Krasnov hydrothermal field. This segment with active and inactive OCC's was surveyed using the Sentry (Autonomous Underwater Vehicle), a towed camera system, water column sensors, magnetometer and gravimeter. Rock samples were also obtained by dredging.

The preliminary data show that the 16.5°N area can be divided in two segments. The northern segment is characterized by a deep axial valley (~4500 m below the sea level), in which the seafloor is covered by a thin layer of volcanic rocks. In contrast, the shallower southern segment (~3300 m below sea level) consists of a robust neovolcanic zone, characterized by a long and continuous axial volcanic ridge. Both segments are bordered to the west by a region with active detachment faulting. We have calculated a total spreading rate in this area of ~24 km/Ma for the last 4 Ma.

Transit legs along both cruises provided an excellent opportunity to map regions of the equatorial Atlantic Ocean and MAR axis previously unexplored. Smith and MacLeod described the 13°N segment of the MAR in which a number of detachment faults extend for 75 km along the western flank of the spreading axis, and a field of extinct core complexes extends westward away from the axis for at least 100 km. Based on the multibeam data alone, we identified extinct OCC's on the eastern and western flanks of the MAR near 13.5°N about 220 km from the axis and on the western flank of the MAR near 23°N, 52°W. Our recent observations suggest that OCC's play a key role in seafloor terrain on the flanks of the MAR as it does bordering the rift valley.

In 2012, we also mapped some areas over the ridge flanks and rift valley. For example, the eastern intra-transform ridge of the Doldrums Fracture Zone (7.3°N, 34.7°W) suggested recent volcanic activity in this short spreading segment. The northern intersection of the axis and transform fault contains a nodal basin about 5000 m in depth, which curves to the west. The southern nodal basin, which is only partially imaged, reaches depths of 5750 m. The western rift mountain at 7.3°N rises to a height of ~2.5 km above the axial valley floor, and has a NW-SE trending crest. Teleseismic earthquakes in this ridge segment are mostly located off-axis although a small number of events are located in the axial valley itself. Since teleseismic earthquake error locations are large, we will have to wait for the hydrophone-recorded seismicity to know if these earthquakes are associated with movement on the transform faults or some other process at the spreading center.

In the next stage of this project, we will recover the hydrophone moorings in 2014 after two years of data acquisition. The data will be analyzed to identify earthquake locations, and used to interpret the seismicity at the ridge axis

and fracture zones in the context of what we know about the geologic structures. The hydrophone data will be made available soon after completion of the cruise. The earthquake locations will also be made available once they are obtained.

The authors wish to thank the Captains, other scientific participants and all crew members aboard both cruises. Funding for this research was provided partly by grants of NSF and InterRidge.

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